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View Menu

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Title:

USING MULTI-SCALE ELECTROMAGNETIC INDUCTION AND SMALL UNOCCUPIED AIRCRAFT SYSTEM SURVEYS TO QUANTIFY SMALL ISLAND FRESH GROUNDWATER DISTRIBUTION IN RESPONSE TO CLIMATIC STRESS

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Abstract:

Long- and short-term climatic patterns (e.g. climate change, El Niño) stress fresh groundwater resources on small islands worldwide through altered precipitation, higher storm surges, and rising sea level. Groundwater/surface-water exchange processes on islands differ from many interior continental settings because they are driven in part by strong contrasts in water density (fresh/salty) and tidal pumping. Therefor unique methodology and modeling strategies are needed to characterize fresh water resources and predict change. Electromagnetic induction (EMI) is well suited to evaluate the variable distribution of fresh and salty groundwater, and can be augmented by long-term monitoring well data (salinity, pressure, temperature) and comprehensive small unoccupied aircraft system (sUAS)-based vegetation surveys.

Palmyra Atoll National Wildlife Refuge is located in the Central Pacific Ocean (5°52’ N, 162°05’ W). We are working at Palmyra Atoll to characterize the interaction between fresh groundwater and surrounding sea water to inform ecological management decisions and increase our understanding of stressed island fresh water resources that can be extrapolated to atolls with greater human population. Field trips in 2008 and 2013 involved repeat hand-held EM surveys (eg GEM2 tool), installation of monitoring

infrastructure, and geochemical sampling. A recent 2016 trip was expanded to include time-domain EMI (Walk-TEM, 20- and 40-m loop) and sUAS natural color, thermal, and multispectral surveys. The monitoring well and near-shore GEM2 data indicate contraction of the fresh groundwater lens since 2013, likely due to the strong recent El Nino event. sUAS surveys were able to clearly classify vegetation type and indicate plant stress. The walk-TEM tool provided a critical portable method to fully-map the fresh-brackish-salty transition along island-scale (e.g. 2 km) transects, understanding that was limited by the GEM-2 depth of investigation. The combined methodology of monitoring well time-series, multi-scale EMI, and broad sUAS multispectral coverage allows comprehensive characterization of small island fresh groundwater resources.

Keywords:

climate change, groundwater, salt water intrusion, electromagnetic induction, drone